

ARMORED MEDICAL RESEARCH LABORATORY
Fort Knox, Kentucky

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Project No. T-3
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1. PROJECT: No. T-3, Test of Expendable Dust Respirator, E5.

a. Authority: Informal request from CMS Development Laboratory.

b. Purpose: To make preliminary observations relative to the adequacy and acceptability of subject respirator.

2. DISCUSSION:

a. This respirator (see Fig. 1) is designed as an expendable item, to be worn for a short time, and then disposed of in favor of a fresh respirator. It is also intended as a protective device against dust as a nuisance rather than as a definite health hazard and is, therefore, not expected to have the extreme efficiency of dust removal required for protection against toxic dusts. For these reasons, in the design of the respirator, high performance has been sacrificed for light weight, comfort and cheapness of construction. The subject respirator was developed by CMS in accordance with design characteristics outlined by Armored Medical Research Laboratory.

b. The foregoing basis of design of the E5 expendable respirator arises from the following arguments and observations:

- (1) The dusts encountered in military operations are not, in general, specifically hazardous from the standpoint of being silicosis-producing, especially in view of the relatively low percentage of free silica generally present; the particle size distribution and the duration of exposure.
- (2) The dust is regarded primarily as a nuisance by tank crews and other military personnel and they will wear protective devices only when the discomfort from the dust is greater than the discomfort of the respirator. Field observations revealed that tank crews in hot desert maneuvers wore handkerchiefs in preference to the highly efficient issue dust respirator.
- (3) Industrial experience, checked by military experience, has demonstrated that one of the most serious limitations to continued use of a respirator is the fact that, without frequent cleaning and servicing, it becomes dirty and disagreeable to wear. To overcome this practical limitation modern industrial practice requires such service daily--a procedure which is clearly impossible under military conditions. The alternative is to provide a cheap, expendable respirator which can be thrown away after a short period of use.

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c. The successful use of any respirator is primarily dependent upon the acceptability of the device by the using troops rather than its absolute protective efficiency. Troops will or will not wear a respirator, depending upon the severity of the exposure on the one hand and the relative comfort of the respirator, on the other. The less comfortable the device, the greater must be the severity of exposure before troops will voluntarily accept it. A mask which is not accepted will be of little value regardless of its dust-protective quality. It is desirable, however, to have some idea of the filtering efficiency and resistance in order to insure reasonably adequate performance.

d. Limited performance tests were carried out in the following manner:

- (1) Test dust--collected from a typical driving range at Fort Knox and screened through a 325-mesh prior to suspension in the test chamber.
- (2) Dust concentration--maintained at approximately constant level above 1000 million particles per cubic foot of air. This represents the higher limits of dust concentrations encountered by tank crew members when driving in close contact with other tanks over extremely dusty terrain.
- (3) In one phase of the test, an E5 respirator was mounted on a "face" in the test chamber and air drawn continuously through it at 1 cfm* for a period of two hours. During this time dust samples were collected periodically from the cabinet air and from the air after passing through the respirator. Resistance to air flow (at 1 cfm) through the respirator was also measured at regular intervals. During this test the respirator was not disturbed and, as a consequence, dust accumulated on it to a degree which would not occur when worn under conditions of field activity. Moreover, the continuous exposure to a dust concentration above 1000 million particles per cubic foot of air, for two hours represents an extreme condition which rarely, if ever, occurs in the field for so long a period. The test was therefore severe in the extreme. Following the test, the respirator was shaken and its resistance build-up again measured over a 1-hour period.
- (4) In the second phase, one of the test respirators was worn continuously for 1 hour, 40 minutes in the test chamber with approximately the same dust concentration as in the first test and with the subject alternately resting and exercising moderately actively in various ways. His observations as to the comfort, resistance and protective value of the respirator were recorded. Air temperature in the chamber was 65-70°F.

3. RESULTS OF TESTS:

a. The quantitative test results are shown graphically in Fig. 2. The dust concentration in the cabinet air was quite constant, varying from 1000 to 1400 million particles per cubic foot. The dust concentration passing the mask

* During the dust-sampling periods from the respirator the rate of air-flow was 1.1 cfm.

was relatively high at the outset (45 million) but decreased in a regular manner as the dust load on the fabric increased, resulting in only 4.5 million at the end of the test. In terms of efficiency, the initial removal of 97% was increased to over 99.5% after 2 hours of use. From the standpoint of protection against a nuisance dust, these results are acceptable, since concentrations of fine particles of 50 million and less are not particularly noticeable nor do such concentrations cause any irritation or discomfort. The resistance at 1 cfm was low at the outset but built up during the two-hour test to over $\frac{1}{2}$ inch. In actual use the instantaneous breathing rate will be 3 cfm or higher and the resistance to breathing would therefore be 9 times greater than the above value, or 4.5 ins*. This excessive resistance, is not to be expected, however, under field conditions for the reasons mentioned above, namely, the extremely high concentration maintained over the period of test and, more important, the fact that the respirator remained undisturbed. After the test moderate shaking of the respirator reduced its resistance to 0.1 ins.

b. Comments of the test subject after 1 hour, 40 minutes wearing of the respirator in the cabinet are summarized, as follows:

- (1) Mask comfortable; fits face well; worn more comfortably with lower edge on chin than under, particularly when talking.
- (2) Resistance to breathing not particularly noticeable during first 60 minutes of use, under conditions of moderate activity as well as resting. Resistance became noticeable but not objectionable during remainder of test. Respirator was not removed for shaking at any time.
- (3) Dust leakage through the respirator was not detectable in terms of irritation, grittiness or discomfort and at termination of test there was no noticeable accumulation of dust on protected portion of face.
- (4) The hook fasteners on the elastic straps caused some irritation owing to its position on back of the neck. A better location would be on the side.

4. CONCLUSIONS:

- a. Preliminary tests indicate that the expendable respirator E5, provides adequate protection against nuisance dusts with no greater resistance to breathing than is expected of any practical respirator.

* U. S. Bureau of Mines Standards for dust respirators permit a maximum inhalation resistance after 90 minutes of test of 2" at 85 liters per minute (3 cfm). The dust concentration employed in the test is, however, approximately one-half of that used in the present tests. It is evident, therefore, that the resistance of the E5 respirator is not excessive in terms of modern standards.

b. Limited observations during use indicate that the respirator is reasonably comfortable and that its dust-removing efficiency is adequate to eliminate all irritation and discomfort associated with breathing dust-laden air.

5. RECOMMENDATIONS:

a. That the E5 expendable respirator with minor modification of harness to eliminate discomfort of hooking device be considered adequate for use by troops insofar as its dust-protective quality is concerned.

b. Recognizing that the acceptability of any dust respirator by troops is primarily dependent upon its relative comfort in relation to severity of dust exposure, that the following action be taken:

- (1) If military operations are anticipated in areas where extreme dust conditions may be encountered, the necessary supply of subject respirator be procured and issued to troops on an expendable basis.
- (2) If operations in such areas is not anticipated in the near future, that a limited supply of the respirators be procured for test of acceptability by troops operating in a military training area of known high dustiness.

(NOTE: The conclusions and recommendations set forth above have been concurred in by Headquarters, Armored Center, W. H. Nutter, Colonel, G.S.C., Chief of Staff).

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- #1 - Fig. 1 (Photograph)
- #2 - Fig. 2 (Chart)



FIG. 1
Expendable Dust Respirator, E5
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FIG. 2
 FILTERING EFFICIENCY AND RESISTANCE
 E5 RESPIRATOR

